(12) UK Patent Application (19) GB (11) 2 278 737 (13) A

(43) Date of A Publication 07.12.1994

(21) Application No 9404369.2

(22) Date of Filing 07.03.1994

(30) Priority Data
(31) 05148460 (32) 27.05.1993 (33) JP

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(51) INT CL^{5}
H02K 5/167, F16C 35/02

(52) UK CL (Edition M)
H2A AKB4B3 AK108 AK111 AK121 AK207 AK214B AK217B AK705 AK812
F2A AD19 A6E2
U1S S2047 S2108

(56) Documents Cited
None

(58) Field of Search
UK CL (Edition M) F2A AD19, H2A AKB4B1 AKB4B3 AKJ1
INT CL^{5} F16C 35/02 35/04 35/06, H02K 5/167 5/173

(54) Miniture motor having bearing device and method for securing bearing device

(57) A miniature motor has a rotor (13, 68, 83) disposed inside a casing (12, 61, 82) having an inner surface on which a stator (11, 65, 81) is mounted. A bearing device supporting a rotation shaft (16, 71, 86) of the rotor comprises a bearing (14, 72, 84, 85) for supporting the rotation shaft in a radial direction thereof. The bearing device also comprises a flat portion (19, 64, 88, 89) formed by the casing and to which the bearing is welded by a laser beam welding method. A motor having a bearing device of the defined structure has a reduced axial length and a compact structure and may be used for a compact disc player.

FIG. 1

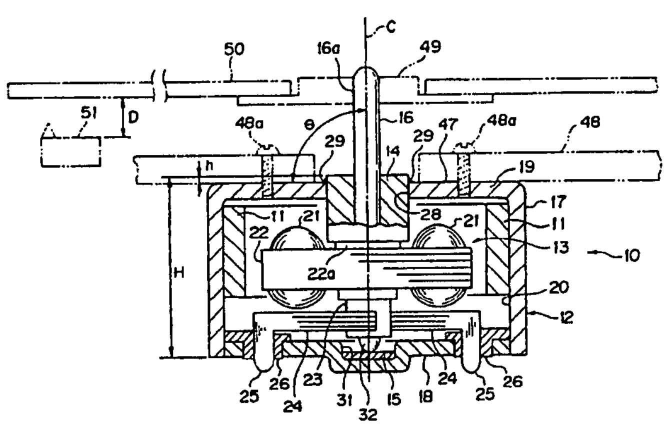
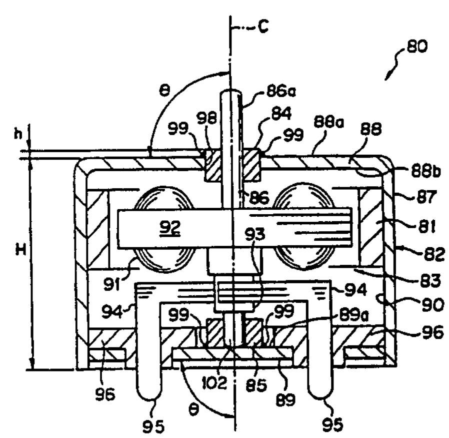


FIG. 7



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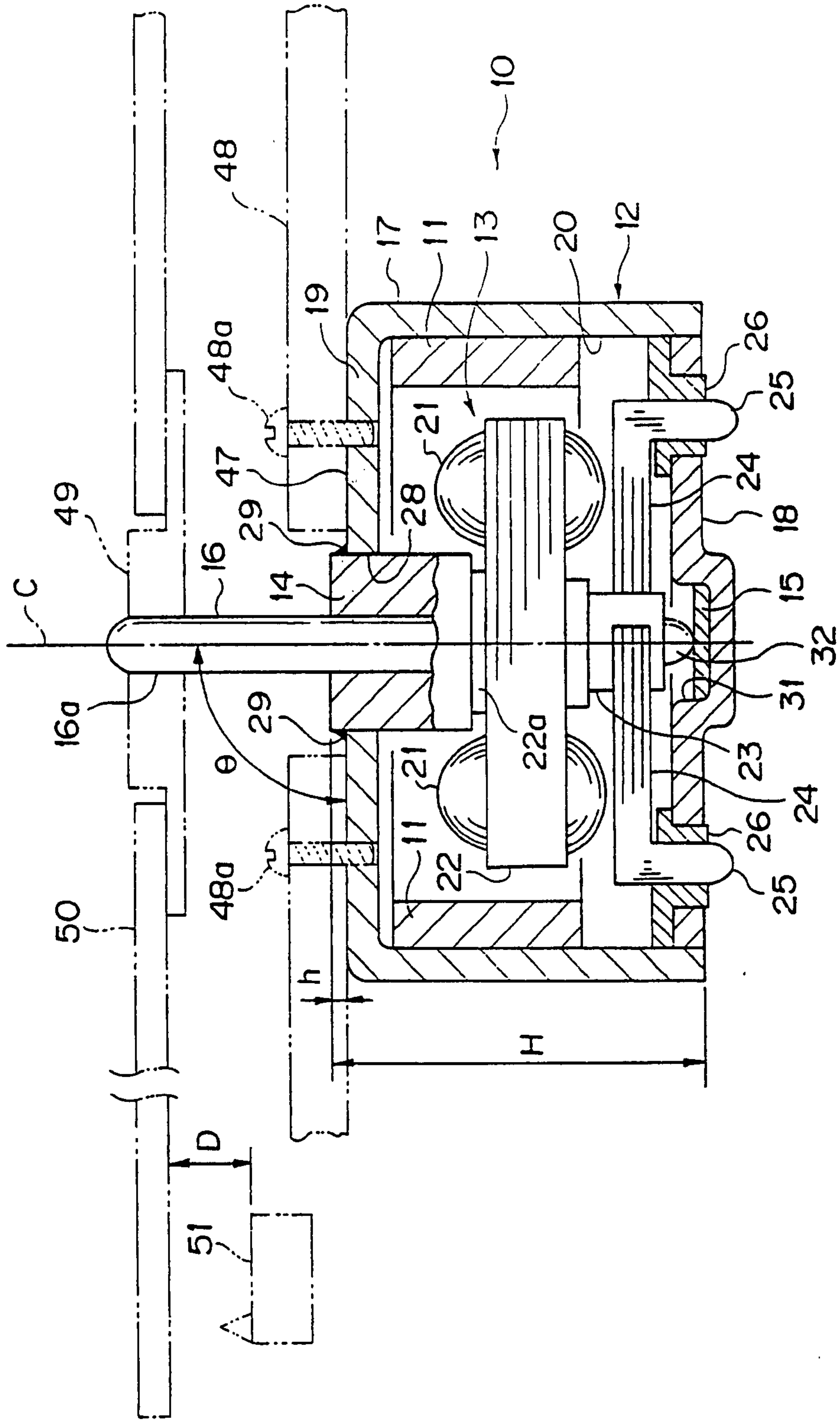

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FIG.1

FIG. 2

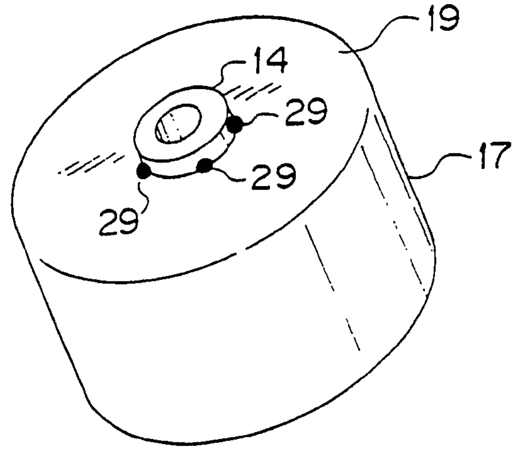

FIG. 3

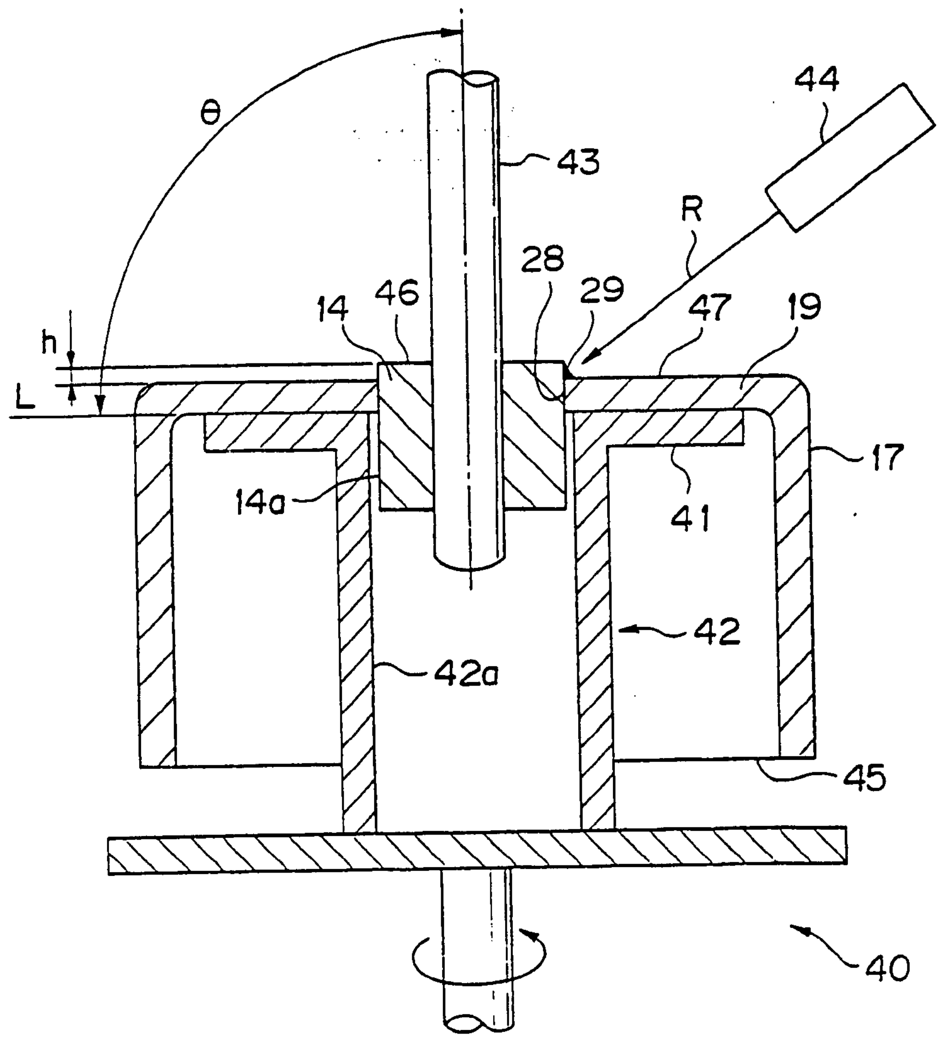

FIG. 4

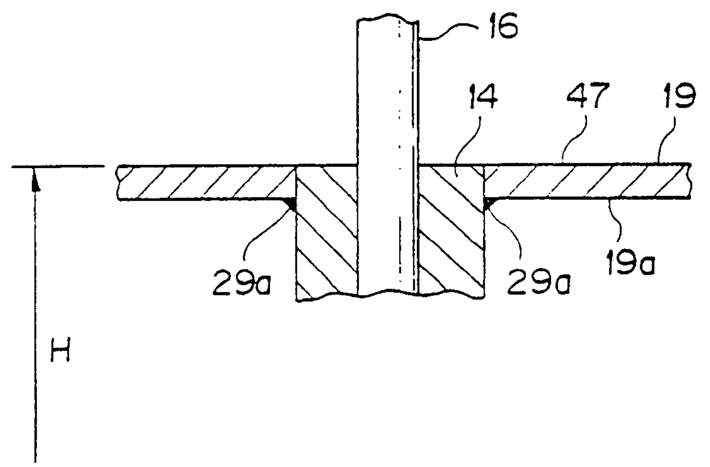
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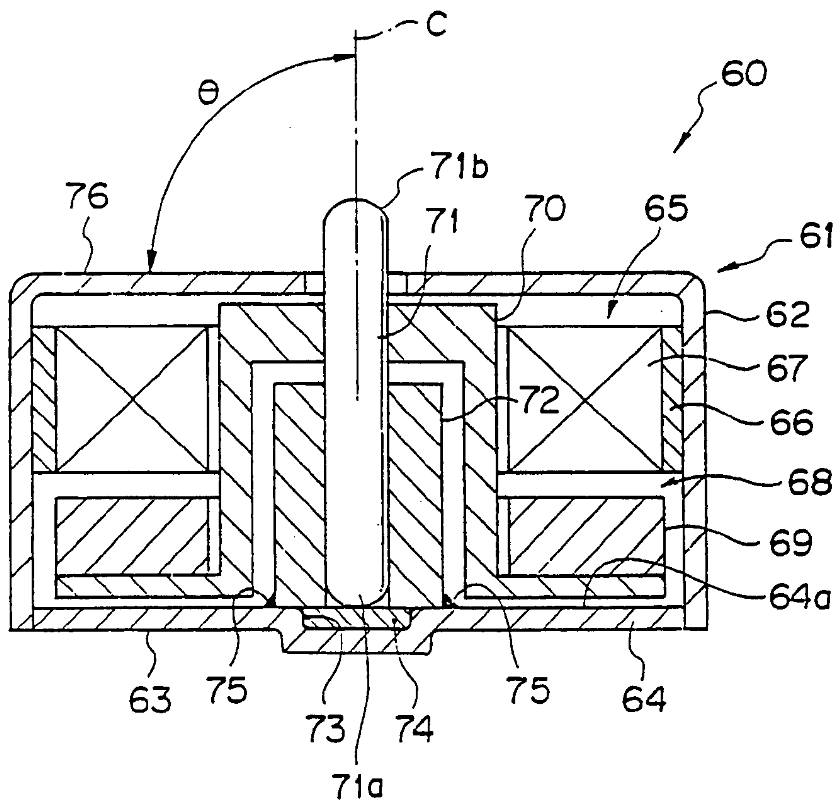
FIG. 5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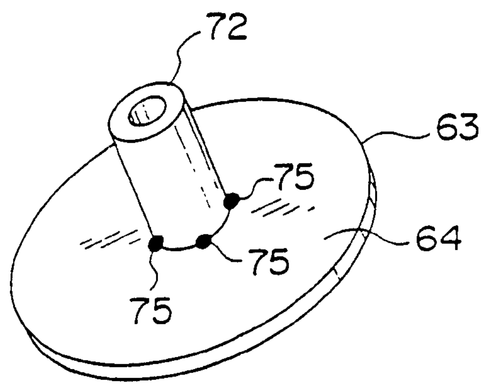
F I G. 6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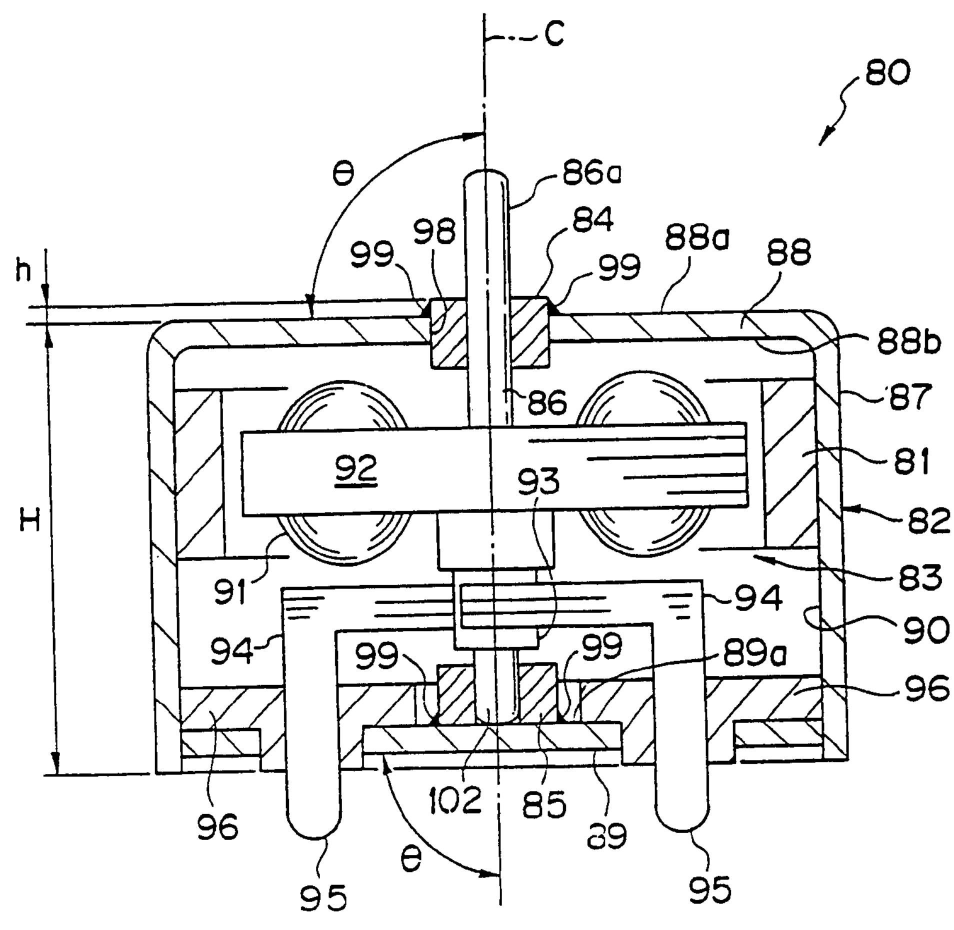
F I G. 7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MINIATURE MOTOR HAVING BEARING DEVICE AND METHOD FOR SECURING BEARING DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to a miniature motor having a bearing device for an audio equipment or a visual equipment, and also relates to a method for securing the bearing device.

In general, a disk reproducing system (for example, compact disk player) operates and rotates a disk, for example CD (compact disk), LD (laser disk), CD-ROM (compact disk ROM) or MD (mini-disk). Information recorded with high density on the rotating disk are read out and reproduced by working a miniature motor incorporated in the reproducing system.

The disk reproducing system includes a potable type system or device which is capable of being carried by hand and has been made compact and thin. For example, an MD in a mini-disk system has a diameter of about 64mm, which is half as small as that of CD having a diameter of about 124mm. A potable type disk reproducing system having a small size capable of being accommodated in a pocket of cloths of a person has recently been introduced. In such potable type system, it is required to decrease the overall dimensions thereof by reducing an entire size or length of a miniature motor accommodated in the system.

In such disk reproducing system, an overall

accuracy of a distance between the disk and an information reading pick-up device significantly affects a reproducing characteristics of the disk reproducing system. For this reason, in a direct drive type miniature motor for directly rotating the disk, it is particularly required that a rotation shaft of the motor is attached to an attachment surface of the motor with the right-angled arrangement so as to exactly read out information recorded on the disk.

In a certain conventional miniature motor, in order to ensure such overall accuracy of the right-angled arrangement, a casing of the motor is stretched out and bent to provide a cylindrical portion projecting outwardly from an upper portion of the casing. A pair of bearings of a bearing device are fitted under pressure into the cylindrical portion and a rotation shaft of the motor is supported by the bearings. However, in a case where the bearings are forcibly set with the right-angled arrangement to the cylindrical portion, an excessive force may be applied to parts of the motor and consequently damages the parts. In order to prevent this defect, it is necessary to improve the overall accuracy of producing all the parts, but there is a limit to such improvement of the overall accuracy of the parts. It is hence difficult to ensure an ideal right-angled arrangement for the rotation shaft in the prior art technique.

In addition, in the conventional motor, since the cylindrical portion is projected outwardly from the upper

portion of the motor by the stretching and bending work, the upper portion includes the projected portion enlarged in size. Therefore, the size of the motor is elongated by an amount corresponding to the projected portion, and a problem for the requirement of reducing the entire length or size of the motor is provided.

Further, in the conventional technique, since the bearings are forcibly fitted in the cylindrical portion, the error in the finishing size of the respective parts constituting the motor affects the overall accuracy of the right-angled arrangement of the rotation shaft. The error results in a problem of hardly ensuring the ideal right-angled arrangement.

Furthermore, according to the conventional structure, since an increased number of parts are required, the structure of the motor itself is made complicated. Therefore, the manufacturing thereof is made difficult and is inconvenient and disadvantageous.

It is an object of the present invention to reduce defects or drawbacks encountered in the prior art and to provide a compact miniature motor which has a bearing device capable of providing the motor with a reduced axial length.

According to a first aspect of the present invention there is provided a miniature motor comprising a bearing

device supporting a rotation shaft of a rotor disposed inside a casing having an inner surface on which a stator is mounted, wherein a flat portion is formed to the casing and a bearing of the bearing device for supporting the rotation shaft in a radial direction thereof is welded to the flat portion.

In an embodiment of the invention a bearing device as defined is capable of ensuring an exact right-angled arrangement of the rotation shaft of the motor.

It is preferred that the bearing is welded to the flat portion of the casing by laser beam welding or arc welding.

In one embodiment of the bearing device, the motor has a cantilever-support type structure for supporting the rotation shaft in a cantilevered manner. The bearing device comprises a radial bearing welded to the flat portion of the casing and a thrust bearing secured to the casing for supporting the rotation shaft. Therefore, the rotation shaft of the rotor can be rotated while it is supported by the radial bearing and the thrust bearing.

In order to weld the radial bearing to the flat portion of the casing, a fitting through hole is first formed in the flat portion and the radial casing is fitted into the fitting hole or the radial bearing disposed inside

the casing is mounted on the other flat portion of the casing. Next, the radial bearing and the flat portion of the casing are welded together while the radial bearing is maintained in a right-angled direction with high squareness with respect to the flat portion of the casing. According to this manner, the radial bearing can be secured to the flat portion without the stretching and bending work of the conventional motor.

In more detail of the preferred embodiment, the flat portion of a housing of the casing has a central portion to which the through hole as fitting hole is formed. The fitting hole has an inner diameter slightly larger than an outer diameter of the radial bearing to be inserted into the fitting hole. The radial bearing fitted into the fitting hole is welded to the flat portion at a plurality of portions arranged along a circumferential direction of the radial bearing. The radial bearing may be welded to one of the outer and the inner surface of the flat portion.

In another embodiment, a miniature motor is a brushless-type D.C. motor. A stator of the motor comprises an armature yoke secured to a casing and a plurality of armature coils mounted inside the armature yoke. A rotor rotated by a magnetic force caused between the stator and the rotor comprises a permanent magnet opposite to the armature coils, a rotor yoke to which the permanent magnet is secured and the rotation shaft secured to a rotation center of the rotor yoke.

According to another aspect of the invention, a miniature motor of a straddle-support type structure in which a bearing device supports a rotation shaft is provided. A casing has a first and a second flat portions being parallel to each other. The bearing device of the motor comprises a first bearing which is welded to the first flat portion and which rotatably supports the rotation shaft, and a second bearing which is welded to the second flat portion and which rotatably supports the rotation shaft.

The first bearing is welded to the first flat portion on an outer surface side of the first flat portion and the second bearing is welded to the second flat portion on an inner surface side of the second flat portion. The first bearing may be welded to the first flat portion on an inner surface side of the first flat portion. In more detail, the first flat portion of a housing has a central portion to which a circular through hole as fitting hole is formed. The fitting hole has an inner diameter slightly larger than an outer diameter of the first bearing to be inserted into the fitting hole. The first bearing fitted into the fitting hole is welded to the first flat portion of the housing at portions to be welded. According to this manner, the first and the second bearings can be secured to the first and the second flat portions, respectively, without effecting the stretching and bending work of the conventional motor.

In a method for securing the bearing device, the welding operation is performed by utilizing an assembling device. The assembling device comprises an assembling jig having a support plate supporting the flat portion, an assembling shaft member for temporarily supporting the bearing, and a laser beam oscillator for irradiating laser beams to portions to be welded. The assembling jig is controlled to be intermittently operated by a predetermined angle repeatedly and a squareness of the assembling shaft member with respect to a reference surface of the supporting plate is maintained with accuracy.

According to the various aspects of the invention described above, the casing of the motor has no cylindrical portion projecting outwardly as in the conventional motor, so that the entire axial length of the motor can be effectively reduced. Thus a compact structure is provided and the motor itself can be manufactured easily with reduced cost. Moreover, the rotation shaft can be directed to a right-angled direction with high squareness with respect to the motor attachment surface of the casing having the flat portion, and consequently easily ensuring the improved squareness.

The natures and features of the invention will be made more clear through the following descriptions of the preferred embodiments with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURES 1 through 4 represent a first embodiment according to the present invention, in which:

FIGURE 1 shows a sectional view of an entire structure of a miniature motor of the invention having a cantilever-support type bearing structure;

FIG. 2 is a perspective view of a portion of the motor of FIG. 1 in which a radial bearing is secured to a casing;

FIG. 3 is a sectional view showing a condition of assembling the motor of FIG. 1 by utilizing an assembling device;

FIG. 4 is a partial sectional view of a modification of FIG. 2, in which the radial bearing and the casing are welded together at portions different from that of FIG. 2;

FIGS. 5 and 6 represent a second embodiment according to the invention, in which:

FIG. 5 is a sectional view showing an entire structure of a miniature motor of the invention having a cantilever-support type bearing structure different from the first embodiment;

FIG. 6 is a view similar to FIG. 2 and is related to the second embodiment; and

FIG. 7 represents a third embodiment according to the invention and is a sectional view showing an entire structure of a miniature motor having a bearing device of a

straddle-support type structure.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first embodiment of a miniature motor of the present invention will be first described hereunder with reference to FIGS. 1 through 4.

FIG. 1 shows a sectional view of a miniature D.C. (direct current) motor 10 as the miniature motor. The D.C. motor 10 has a cantilever-support type bearing structure and is provided with a brush means. The motor 10 comprises a casing 12 having an inner peripheral portion on which a stator 11 is mounted and a rotor 13 disposed inside the casing 12. The rotor 13 has a rotation shaft 16 rotatably supported by a radial bearing 14 and a thrust bearing 15, and both bearings 14 and 15 of a bearing device are secured to the casing 12. The radial bearing 14 and the thrust bearing 15 support the rotation shaft 16 with respect to a radial direction and a thrust direction respectively.

The casing 12 comprises a housing 17 formed out of a metal material (for example, cold rolled steel plate sheet and strip in cut length of soft steel material) and a bottom plate member 18 formed in a disk shape. The housing 17 is formed in a shape of a hollow cylinder having a closed bottom. The bottom plate member 18 is fitted and secured to an end opening 45 of the housing 17 and is formed out of the same material as that of the housing 17. The surfaces of the housing 17 and the bottom plate member 18 are zinc

plated.

The housing 17 is integrally formed by a press molding process so as to provide the bottomed hollow cylindrical structure. The housing 17 is provided with a disk-like flat portion 19 having an upper (i.e. outer) surface 47 serving as an attachment surface of the motor 10.

The stator 11 is secured to an inner peripheral surface 20 of the hollow cylindrical structure of the housing 17. The stator 11 is composed of a pair of permanent magnets formed in arc-segment shape. The permanent magnets are formed out of a magnetic material (for example, hard ferrite) and oppositely disposed to each other. The rotor 13 comprises a rotation shaft 16 extending in a direction of a central axis C as a rotation center, a rotor core 22 which is mounted to the rotation shaft 16, and a commutator 23 of cylindrical structure mounted to the rotation shaft 16. An armature winding 21 is wound in shape of coil around the rotor core 22 and the commutator 23 is electrically connected to the armature winding 21. The rotor core 22 is arranged inside the stator 11 with a predetermined air-gap between the rotor core 22 and the stator 11. An adjustment washer 22a of annular ring structure for adjusting an axial position of the rotor 13 is disposed in a non-fixing state between the rotor core 22 and the radial bearing 14.

Plural brushes (for example, two pairs of brushes) 24 formed out of an electrically conductive material are

provided to the bottom plate member 18 so as to be slidingly engaged with the commutator 23. Plural connecting terminals (for example, two pairs of connecting terminals) 25 electrically connected to the respective brushes 24 are secured to the bottom plate member 18 through electrically insulating members 26.

A circular through hole 28 as a fitting hole is formed to a central portion of the flat portion 19 of the housing 17. The through hole 28 has an inner diameter slightly larger than an outer diameter of the radial bearing 14. The radial bearing 14 is fitted into the through hole 28 and then is welded to the flat portion 19 by means for welding at a plurality of welded portions 29.

In a case where the welding operation is carried out, as shown in FIG. 2, the radial bearing 14 is welded to the housing 17 at a plurality of welded portions 29 separated in the circumferential direction of the radial bearing 14. The welded portions 29 are equally positioned at every angle of 90°, for example. As a result, the radial bearing 14 can be firmly secured to the housing 17 and the firm welding strength is ensured. The radial bearing 14 has a hollow cylindrical structure extending in its axial direction and the rotation shaft 16 is fitted into a hollow inside portion of the bearing 14. The rotation shaft 16 is cantilevered in the radial direction by the bearing 14.

Since the radial bearing 14 is formed out of a metal material, the radial bearing 14 may be secured to the

flat portion 19 of the housing 17 by means for welding such as arc welding or another welding. In a case where the radial bearing 14 is formed out of either iron-copper series powder sintered metal or powder sintered alloy and is impregnated with a lubrication oil, it is preferred to secure the bearing 14 to the flat portion 19 by means of laser welding. The laser welding method is a method for performing the welding operation by irradiating a laser beam and applying its light energy to the portions 29 to be welded. A CO_2 laser beam welding method, YAG (Yttrium Aluminum Garnet) laser beam welding method or another laser beam welding method may be utilized.

The bottom plate member 18 has a central portion to which a circular recessed portion 31 is integrally formed so as to protrude outward. The recessed portion 31 has a bottom on which the thrust bearing 15 is fixedly pressed in a non-rotatable state. The thrust bearing 15 is formed out of either steel plate or plastic material. A lower end portion 32 of the rotation shaft 16 is in contact with the thrust bearing 15 to be rotatable, accordingly the rotation shaft 16 is supported in the thrust direction by the thrust bearing 15.

As described above, according to the bearing device of the motor of the invention, the rotation shaft 16 is rotatably supported by the radial bearing 14 and the thrust bearing 15.

The motor 10 provided with the brushes of the

structure described above will be assembled in the following manner.

In an assembling, an assembling device 40 as shown in FIG. 3 is utilized. The assembling device 40 comprises an assembling jig 42 having a support plate 41 for supporting the flat portion 19 of the housing 17, an assembling shaft member 43 for temporarily supporting the radial bearing 14 and a laser oscillator 44 for irradiating a laser beam R to the portions to be welded. The assembling jig 42 is operated under a control that the jig 42 can be intermittently rotated repeatedly by a predetermined angle, for example 90°. The squareness θ of the assembling shaft member 43 with respect to a reference surface L of the support plate 41 is maintained to be extremely accurate.

First the housing 17 which is formed by press molding and which has the fitting hole 28 is temporarily secured on the reference surface L of the support plate 41 in a state that the end opening 45 of the housing 17 directs downward. The assembling shaft member 43 is then inserted in the radial bearing 14 to thereby temporarily secure the radial bearing 14 to the assembling shaft member 43.

In the next step the assembling shaft member 43 is relatively moved towards the assembling jig 42, so that the radial bearing 14 is fitted into the fitting hole 28. In this operation it is necessary for the assembling jig 42 to have an inner periphery 42a having a diameter so as not to contact an outer periphery 14a of the radial bearing 14.

That is, the assembling jig 42 has an inner diameter larger than the outer diameter of the radial bearing 14. The assembling shaft member 43 is set in the assembling jig 42 such that the insertion of the radial bearing 14 into the assembling jig 42 is stopped at a time when an upper end portion 46 of the radial bearing 14 is positioned slightly above an upper surface 47 of the flat portion 19 by a minimum distance h required for the laser beam welding.

In this state, the assembling jig 42 and the assembling shaft member 43 are integrally intermittently rotated and stopped by the predetermined angle. When the rotation is temporarily stopped the laser beam R is irradiated from the laser oscillator 44 to the portions 29 to be welded. As a consequence, the radial bearing 14 is fixedly welded to the flat portion 19 of the housing 17 and is positioned to the same with high accuracy of the squareness θ.

The assembling shaft member 43 is drawn from the radial bearing 14 and the housing 17 to which the radial bearing 14 is firmly secured is then separated from the assembling jig 42.

Next, as shown in FIG. 1, the stator 11 is secured to the inner peripheral surface 20 of the housing 17, and the rotation shaft 16 of the rotor 13 is inserted into the radial bearing 14, accordingly the rotor 13 is accommodated inside the housing 17. The thrust bearing 15 is fitted and fixed under pressure to the recessed portion 31 of the

bottom plate member 18 to which the brushes 24 are attached. The bottom plate member 18 is fitted into the opening portion 45 of the housing 17 and is fixed thereto. Consequently, the rotor 13 is rotatably supported by the radial bearing 14 and the thrust bearing 15. Thus the assembling of the miniature D.C. motor 10 having the bearing device and provided with the brush means is completed.

The completed motor 10 is provided with the flat portion 19 as an attachment portion having the upper surface 47 which closely contacts an attachment plate 48 of a disk reproducing system, for example compact disk player. Then the flat portion 19 and the attachment plate 48 are fastened by machine screws 48a and a turntable 49 is fitted and fixed under pressure to an upper output portion 16a of the rotation shaft 16.

In the motor 10 of the structure described above, when an electric current flows to the armature winding 21 from the connection terminals 25 through the brushes 24 and the commutator 23, a rotation force is applied to the rotor 13 positioned in a magnetic field generated by the stator 11 composed of a pair of permanent magnets and as a result the rotor 13 is rotated.

According to the rotation of the rotor 13, the rotation shaft 16 and the turntable 49 are rotated and an optical disk 50 (for example, CD, LD, CD-ROM or MD) mounted on the turntable 49 is rotated. Information recorded on the optical disk 50 is read out and reproduced by an optical

pick-up device 51.

According to the bearing device and the assembling method, the radial bearing 14 is fixed to the flat portion 19 of the housing 17 by the means for welding, for example laser beam welding technique. Therefore, there is no need for providing the cylindrical portion projecting outward formed by the stretching and bending work required in the conventional technique. Consequently, the radial bearing 14 has a portion slightly extending over the upper, i.e. outer, surface 47 of the housing 17 by the minimum distance h required for the welding work. As a result, an entire axial length H of the motor can be reduced in comparison with the conventional motor of this type.

The radial bearing is fixedly pressed into the cylindrical portion of the casing in the conventional motor. However, according to the invention, the rotation shaft 16 can be positioned with the high squareness θ with respect to the upper surface 47 of the flat portion 19 as the motor attaching surface. As a consequence, the present embodiment can extremely improve the accuracy of the squareness even without remarkably improving the working efficiency of respective parts of the motor 10 in comparison with the conventional bearing device of the conventional motor. Moreover, the parts of the motor 10 can be prevented from being damaged so that the motor 10 is advantageous in comparison with the conventional motor in which the parts is damaged at the time when they are pressed into the

cylindrical portion. Further, the structure of the bearing device of the invention itself is made compact. The stretching and bending of the casing of the conventional motor described above can be eliminated. As a result, the motor 10 is produced in easy manufacturing with reduced cost.

In this first embodiment, the radial bearing 14 is welded to the flat portion 19 on the side of the upper surface 47 exposed outside the motor. However, in an alternation, the radial bearing 14 may be welded to the flat portion 19 on a side of an inner surface 19a of the flat portion 19 positioned inside the motor as shown in FIG. 4. According to this alternation, since welded portions 29a are not exposed outside the motor, the radial bearing 14 does not project over the outer surface 47 of the flat portion 19 and the entire axial length H of the motor is further reduced. The welded portions 29a are positioned with every equal distances along the circumferential direction of the radial bearing 14.

A second embodiment of the invention will be described hereunder with reference to FIGS. 5 and 6.

FIG. 5 shows a sectional view of an entire structure of a miniature D.C. motor 60 provided with no brush means, so-called brushless-type miniature D.C. motor. FIG. 6 shows that a radial bearing is secured to a casing of the motor 60.

Referring to FIG. 5, the motor 60 is used for the

rotation driving of the optical disk (for example CD) likely for the miniature D.C. motor 10 provided with brushes. The motor 60 is provided with the cantilever-support type bearing structure. The casing 61 of the motor 60 comprises a hollow cylindrical bottomed housing 62 integrally molded by a press working and a bottom plate member 63 of disk like structure fitted and secured to an opening portion of the housing 62. The bottom plate member 63 is provided with a disk-like flat portion 64.

A stator 65 disposed inside the housing 62 comprises an armature yoke 66 secured to the housing 62 and a plurality of armature coils 67 attached to an inner peripheral surface of the armature yoke 66.

A rotor 68 disposed inside the casing 61 comprises a permanent magnet 69 opposite to the armature coils 67, a rotor yoke 70 to which the permanent magnet 69 is secured and a rotation shaft 71 secured to a rotation center portion of the rotor yoke 70. An electricity conducting timing of the armature coils 67 is controlled by means for detecting a rotor position (for example, hole element) and means for controlling a commutation and then the armature coils 67 is exited, so that magnetic poles are generated. The permanent magnet 69 is formed out of either ferrite magnet or plastic neodymium magnet and is attracted by the magnetic poles generated by the armature coils 67 and as a result the rotor 68 is rotated.

A radial bearing 72 of a bearing device is secured

to a central portion of the flat portion 64 of the casing 61 by means for welding, for example laser beam welding. The radial bearing 72 has a hollow cylindrical structure extending in its axial direction. A rotation shaft 71 is fitted into a hollow inside portion of the cylindrical structure of the radial bearing 72 so that the rotation shaft 71 is cantilevered by the radial bearing 72 in the radial direction.

The bottom plate member 63 has a central portion to which a circular recessed portion 73 is integrally formed so as to protrude outward. A thrust bearing 74 formed out of either steel plate or plastic plate is pressed and fitted in the recessed portion 73 in a non-rotatable state. A lower end portion 71a of the rotation shaft 71 abuts against the thrust bearing 74 to be rotatable, and the rotation shaft 71 is supported in the thrust direction by the thrust bearing 74. Therefore, the rotation shaft 71 is rotatably supported by the bearings 72 and 74 of the bearing device. The turntable 49 (see FIG. 1) is also secured to an upper output portion 71b of the rotation shaft 71.

The radial bearing 72 is welded to the central portion of an inner surface 64a of the flat portion 64 at a plurality of portions 75 to be welded by means of laser beam welding. The portions 75 to be welded are arranged with equal distances along the circumferential direction of the radial bearing 72. The laser beam welding method by which the radial bearing 72 is welded to the bottom plate member

63 is performed substantially in the same manner as described with reference to the first embodiment by using the assembling device 40 shown in FIG. 3. The casing 61 is formed out of the same material as that of the casing 12 of the first embodiment.

According to this second embodiment, the casing 61 composed of the housing 62 and the bottom plate member 63 can be produced and assembled with high accuracy. Therefore, the rotation shaft 71 can be positioned with high accuracy of the squareness θ with respect to an upper surface 76 of the housing 62 as a motor attachment surface. Substantially the same functions and effects as those of the first embodiment can also be attained by the second embodiment.

A third embodiment according to the invention will be described hereunder with reference to FIG. 7. FIG. 7 shows a sectional view of an entire structure of a miniature motor having a bearing device of a straddle-type structure according to the invention.

Referring to FIG. 7, a miniature D.C. motor 80 provided with brush means comprises a casing 82 in which a stator 81 is disposed and a rotor 83 disposed inside the casing 82. The rotor 83 is provided with a rotation shaft 86 which is rotatably supported by a first and a second bearings 84 and 85 constituting a bearing device secured to the casing 82.

The casing 82 is provided with a hollow

cylindrical bottomed housing 87 having an opening portion, and a bottom plate member 89 of disk-like structure fitted and secured to the opening portion of the housing 87. The bottom plate member 89 is formed out of the same material as that of the housing 87. The housing 87 has a circular first flat portion 88 which is positioned in parallel to the bottom plate member 89 being as a second flat portion.

The housing 87 is integrally formed by a press molding method and an upper surface 88a of the first flat portion 88 is constituted as a motor attachment surface. The casing 82 will be formed out of the same material as that of the casing 12 (see FIG. 1) of the first embodiment.

The stator 81 is mounted on an inner peripheral surface 90 of the hollow cylindrical housing 87 and is composed of a pair of permanent magnets as like in the first embodiment. The permanent magnets are oppositely disposed to each other.

The rotor 83 comprises the rotation shaft 86 extending in the central axis C as a center of the rotation, a rotor core 92 which is mounted to the rotation shaft 86 and around which an armature winding 91 is wound in shape of coil, and a commutator 93 of cylindrical structure mounted to the rotation shaft 86 and electrically connected to the armature winding 91. The rotor core 92 is disposed inside the stator 81 with a predetermined air-gap therefrom.

Plural pairs of brushes (for example, two pairs of brushes) 94 formed out of an electrically conductive

material are provided for the bottom plate member 89 so as to be slidingly engaged with the commutator 93. Plural pairs of connection terminals (for example, two pairs of connection terminals) 95 electrically connected to the brushes 94, respectively, are attached to the bottom plate member 89 through electrically insulating members 96.

The central portion of the first flat portion 88 is formed with a circular through hole 98 as a fitting hole having an inner diameter slightly larger than an outer diameter of the first bearing 84. The first bearing 84 fitted into the fitting hole 98 is welded at a plurality of welded portions 99 to the first flat portion 88.

In the same manner shown in FIG. 2 with respect to the first embodiment, the first bearing 84 is welded to the housing 87 at the portions 99 to be welded positioned with equal spaces (for example, at every angle of 90°) along the circumferential direction of the bearing 84. As a result, the first bearing 84 is firmly welded and secured to the housing 87. The rotation shaft 86 is rotatably fitted in the first bearing 84 which supports the upper portion of the rotation shaft 86 in the radial direction.

The first bearing 84 formed out of a metal material can be secured to the first flat portion 88 by any suitable means for welding such as arc welding and laser beam welding. In a case where the first bearing 84 is formed out of either iron-copper series powder sintered metal or powder sintered alloy and is impregnated with

lubricating oil, it will be preferred to weld the first bearing 84 to the first flat portion 88 by the laser beam welding method as described with reference to the first embodiment.

The bottom plate member 89 is provided with an inner side central portion to which the second bearing 85 is welded at a plurality of portions 99 by the means for welding. The second bearing 85 is formed out of the same material as that of the first bearing 84. The rotation shaft 86 has a lower end portion 102 which is rotatably fitted into the second bearing 85. The second bearing 85 supports the lower end portion 102 in the radial and the thrust directions.

As described above, according to the third embodiment of the invention, the bearing device of the motor 80 comprises the first and the second bearings 84 and 85 which rotatably support the rotation shaft 86.

When the first bearing 84 is welded to the first flat portion 88 by the laser beam welding, the assembling device 40 shown in FIG. 3 and utilized in the first embodiment can also be utilized. The second bearing 85 is welded to the bottom plate member 89 by means of the laser beam welding by also using the assembling device 40.

The upper surface 88a of the first flat portion 88 as the attachment surface of the motor 80 is fastened to the attachment plate 48 (see FIG. 1) of the disk reproducing system by means of machine screws. The turntable 49 (see

FIG. 1) is fixed to the upper output portion 86a of the rotation shaft 86.

With the motor 80 having such structure, when an electric current passes from the connection terminals 95 to the armature windings 91 through the brushes 94 and the commutator 93, the rotating force is applied to the rotor 83 disposed in a magnetic field generated by the stator 81 composed of the paired permanent magnets, accordingly the rotor 83 is rotated.

Therefore, like the first embodiment shown in FIG. 1, the rotation shaft 86 and the turntable 49 are rotated and the optical disk 50 mounted on the turntable 49 is rotated. Information recorded on the optical disk 50 can be read out and reproduced by the optical pick-up device 51.

According to the motor 80 having the bearing device and the method for securing the bearing device of the third embodiment, the first and the second bearings 84 and 85 are fixedly welded to the first flat portion 88 of the housing 87 and the inner surface 89a of the bottom plate member 89 respectively. The formation of the cylindrical portion to the casing by the stretching and bending in accordance with the conventional technique can be eliminated. Consequently, the first bearing 84 has a minimum portion extending over the upper surface 88a of the housing 87 by a necessary distance h for the welding work. Thus the entire axial length H of the motor 80 is effectively reduced.

According to the third embodiment, the rotation shaft 86 can be positioned with high accuracy of the squareness θ with respect to the first flat portion 88 and the bottom plate member 89. Consequently, the overall accuracy of the squareness θ can be extremely improved without increasing so high an overall accuracy of respective parts of the motor in comparison with the conventional bearing device in which the first and the second bearings are fitly pressed into the cylindrical portion of the casing of the motor with high accuracy. An elimination of the press fitting results in no application of forcible force to the parts of the motor and as a result the parts are not damaged. The structure of the bearing device of this embodiment can be made compact and the stretching and bending work can be eliminated, so that the motor itself can be easily manufactured.

In the third embodiment, the first bearing 84 is welded to the first flat portion 88 on the upper surface side 88a of the flat portion 88. However, as described with reference to FIG. 4, the first bearing 84 may be welded to the first flat portion 88 on an inner surface side 88b thereof. In this alternation, the welded portions 99 do not position at the outer surface of the motor 80, accordingly the first bearing 84 dose not extend over the upper surface 88a of the flat portion 88. The entire length H of the motor 80 can be further reduced.

As described above, in the disk reproducing system

like the first embodiment shown in FIG. 1, it is necessary to maintain constant distance D between the optical disk 50 and the optical pick-up device 51. The distance D can be constantly ensured with high accuracy according to the direct-drive type miniature motors 10, 60 and 80 of the invention. As a result, information recorded on the optical disk 50 can be exactly read out and reproduced by the optical pick-up device 51.

Preferably the bearing device is welded by utilizing the laser beam oscillator 44 as shown in FIG. 3 in the welding method of the invention. Since it is not necessary to utilize a welding rod in such laser beam welding method, the laser beam R can be irradiated from a portion apart from the portions 29, 75 and 99 to be welded so that the welding work can be made easily without danger. More precise welding can be done to small area to be welded with substantially no formation of protruded portions.

The welding can be done by a spot welding method to a plurality of welded portions as described above, but the welding may also be done by a continuous welding method to a continuous welded portion. According to the invention, since the bearing device can be precisely positioned to the casing, the rotation shaft can smoothly rotate without a vibration.

In alternations or modifications, a casing having a circular cross section to which a pair of flat portions are formed or having a rectangular cross section may be

utilized other than the casings 12, 61 and 82 having a circular cross section. Therefore, the flat portions 19, 64, 88 and 89 may have shapes other than the circular or disk shape.

Further, the invention can be applied to rotation-type miniature motors such as alternating-current motors other than the D.C. motors described in the above embodiments. Magnetic disks such as FD (flexible disk), hard disk and other disk other than the optical disk may also be used as a disk to be driven by the miniature motor of the invention.

In the embodiments illustrated in the respective figures, like reference numerals denote the same portions or parts.

Those skilled in the art will appreciate that a variety of changes and modifications to the present invention can be made without departing from the spirit and scope of the invention as defined by the appended claims.

CLAIMS

1. A miniature motor comprising a bearing device supporting a rotation shaft of a rotor disposed inside a casing having an inner surface on which a stator is mounted, wherein a flat portion is formed to the casing and a bearing of the bearing device for supporting the rotation shaft in a radial direction thereof is welded to the flat portion.

2. A miniature motor as claimed in Claim 1, wherein said bearing is welded to the flat portion of the casing, for example, by laser beam welding or arc welding.

3. A miniature motor as claimed in Claim 2, wherein said means of laser beam welding is either CO_2 laser beam welding or YAG laser beam welding.

4. A miniature motor as claimed in any preceding claim, wherein said bearing is formed out of iron-copper series powder sintered metal or powder sintered alloy and is impregnated with lubricating oil, and said bearing is welded to said flat portion of the casing by means of laser beam welding.

5. A miniature motor as claimed in any preceding claim, wherein said bearing is welded at a plurality of portions which are positioned with equal spaces with each other along a circumferential direction of the bearing.

6. A miniature motor as claimed in any preceding claim, wherein said rotation shaft has an output portion to which a turntable is mounted, and information recorded on an optical disk mounted on the turntable is read out by an optical pick-up device.

7. A miniature motor as claimed in any preceding claim,

wherein said bearing device of the motor has a cantilever-support type structure for supporting the rotation shaft in a cantilevered manner and comprises a radial bearing welded to the flat portion of the casing; and a thrust bearing secured to the casing for supporting the rotation shaft.

8. A miniature motor as claimed in Claim 7, wherein said radial bearing has an axially extending hollow cylindrical structure in which the rotation shaft is rotatably fitted, and the radial bearing supports the rotation shaft in the cantilevered manner in the radial direction.

9. A miniature motor as claimed in any preceding claim, wherein the motor is a direct current motor provided with brush means; said stator is mounted on an inner peripheral surface of the cylindrical structure of the casing, the stator comprises a pair of permanent magnets formed out of a magnetic material in shape of arc segments and arranged oppositely to each other; and said rotor rotates inside the permanent magnets and comprises the rotation shaft, and a rotor core and a commutator both mounted on to the rotation shaft.

10. A miniature motor as claimed in Claim 9, wherein the magnetic material of the stator permanent magnets is a hard ferrite material.

11. A miniature motor as claimed in Claim 9 or Claim 10, wherein an annular washer member is interposed between the rotor core and the radial bearing in a non-contact state for adjusting an axial position of the rotor.

12. A miniature motor as claimed in any preceding claim, wherein said casing comprises a hollow cylindrical bottomed housing formed out of a metal material of cold rolled steel plate sheet and strip in cut length of soft steel material; and a bottom plate member formed out of the same material as

that of the housing and fitted and secured to an end opening of the housing.

13. A miniature motor as claimed in Claim 12, wherein said housing is provided with the flat portion having an outer surface as a motor attachment surface.

14. A miniature motor as claimed in Claim 12 or Claim 13, wherein the flat portion has a central portion to which a through hole as fitting hole is formed, said fitting hole having an inner diameter slightly larger than an outer diameter of a radial bearing to be inserted into the fitting hole; and the radial bearing fitted into the fitting hole is welded to the flat portion at a portion to be welded.

15. A miniature motor as claimed in any of Claims 12 to 14, wherein the hollow cylindrical bottomed housing is provided with an outer surface as a motor attachment surface and the bottom plate member is provided with the flat portion.

16. A miniature motor as claimed in any of Claims 12 to 15, wherein the bottom plate member is provided with a bottomed recessed portion at its central portion, said recessed portion being integrally formed with the bottom plate member and protruding outward, and said recessed portion having a bottom on which a thrust bearing for supporting the rotation shaft is pressed, one end portion of the rotation shaft rotatably abutting against the thrust bearing.

17. A miniature motor as claimed in Claim 16, wherein said thrust bearing is formed out of a steel plate.

18. A miniature motor as claimed in Claim 16, wherein said thrust bearing is formed out of a plastics material.

19. A miniature motor as claimed in any preceding claim,

further comprising a radial bearing for supporting said rotation shaft, and wherein said radial bearing is welded to an inner surface of said flat portion.

20. A miniature motor as claimed in any of Claims 1 to 8, wherein the motor is a brushless-type D.C. motor; wherein the stator comprises an armature yoke secured to the casing and a plurality of armature coils mounted inside the armature yoke; the rotor which is rotated by a magnetic force caused between the stator and the rotor comprises a permanent magnet opposite to the armature coils, a rotor yoke to which the permanent magnet is secured and the rotation shaft secured to a rotation centre of the rotor yoke.

21. A miniature motor as claimed in any of Claims 1 to 19, wherein the bearing device of the motor has a straddle-support type structure for supporting the rotation shaft and the casing is provided with a first and a second flat portions being parallel to each other; and wherein said bearing device comprises a first bearing which is welded to the first flat portion and which rotatably supports the rotation shaft, and a second bearing which is welded to the second flat portion and which rotatably supports the rotation shaft.

22. A miniature motor as claimed in Claim 21, wherein said first bearing is welded to the first flat portion on an outer surface side of the first flat portion and said second bearing is welded to the second flat portion on an inner surface side of the second flat portion.

23. A miniature motor as claimed in Claim 21, wherein said first bearing is welded to the first flat portion on an inner surface side of the first flat portion.

24. A miniature motor as claimed in any of Claims 21 to 23, wherein the motor is a direct current motor provided with

brush means; wherein said stator comprises a pair of permanent magnets oppositely mounted on an inner peripheral surface of the casing; and said rotor to be rotated inside the permanent magnets comprises the rotation shaft, and a rotor core and a commutator both mounted on the rotation shaft .

25. A miniature motor as claimed in any of Claims 21 to 24, wherein said first flat portion is formed to the hollow cylindrical bottomed housing of the casing and said second flat portion is constituted of a bottom plate member fitted to an opening of the housing.

26. A miniature motor as claimed in Claim 25, wherein an outer surface of the first flat portion constitutes a motor attachment surface.

27. A miniature motor as claimed in Claim 25 or Claim 26, wherein said bottom plate member is provided with an inner central portion to which said second bearing formed out of the same material as that of the first bearing is welded at a portion to the bottom plate member, and one end portion of the rotation shaft is fitted to the second bearing, said second bearing supporting the one end portion of the rotation shaft in the radial direction and a thrust direction.

28. A miniature motor as claimed in any of Claims 21 to 27, wherein the first flat portion of the housing has a central portion to which a circular through hole as fitting hole is formed, said fitting hole having an inner diameter slightly larger than an outer diameter of the first bearing to be inserted into the fitting hole and the first bearing fitted into the fitting hole is welded to the first flat portion at a portion to be welded.

29. A method for securing a bearing device of a miniature motor having a casing to which a stator is mounted and in

which a rotor is disposed, the bearing device supporting a rotation shaft of the rotor, and wherein a bearing for supporting the rotation shaft in a radial direction thereof is welded to a flat portion of the casing.

30. A method as claimed in Claim 29, wherein said bearing is welded to the flat portion by means of laser beam welding.

31. A method as claimed in Claim 29 or Claim 30, wherein the welding operation is performed by utilizing an assembling device, said assembling device comprising; an assembling jig having a support plate supporting the flat portion; an assembling shaft member for temporarily supporting the bearing; and a laser beam oscillator for irradiating laser beams to a portion to be welded; wherein the assembling jig is controlled to be intermittently operated by a predetermined angle repeatedly and a squareness of the assembling shaft member with respect to a reference surface of the supporting plate is maintained with accuracy.

32. A miniature motor substantially as hereinbefore described with reference to the accompanying drawings.

33. A method of securing a bearing device to a miniature motor substantially as hereinbefore described with reference to the accompanying drawings.

Patents Act 1977 **Examiner's report to the Comptroller under Section 17** **(The Search report)** -34-	Application number GB 9404369.2
Relevant Technical Fields (i) UK Cl (Ed.M) H2A (AKB4B3, AKB4B1, AKJ1); F2A (AD19) (ii) Int Cl (Ed.5) H02K 05/167, 05/173; F16C 35/02, 35/04, 35/06	Search Examiner J COCKITT Date of completion of Search 27 MAY 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii)	Documents considered relevant following a search in respect of Claims :- 1-33

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